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TEACHER
MANUAL

TAG

"TAGGING AND RECOVERY" METHOD FOR WILDLIFE POPULATION STUDY

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HUNTINGTON TWO COMPUTER PROJECT

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TAG

TEACHER MANUAL

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TAG

TEACHER MANUAL

I. BASIC INFORMATION ABOUT THE UNIT

Subject Area:	Biology, general science, general math
Specific Topic:	Population biology
Grade Level:	9 - 11
Coordinated **Computer Program:**	*TAG*
Computer Language:	BASIC
Special Language **Features Used:**	RANDOMIZE
Abstract:	The *TAG* program provides students with an opportunity to investigate the size of a wildlife population through the technique of tagging and recovery. *TAG* uses the large-mouth bass population of a simulated farm pond as the study species.

II. INTRODUCTION TO THE *TAG* UNIT

To scientists interested in the preservation of wildlife, it is of fundamental importance to be able to know the current condition of the species they wish to aid. In most cases, they must be able to get a reliable estimate of the numbers of a particular species present before they can hope to manage or aid them. The most obvious method of determining the population is to go out and count all the animals. This is not always possible, especially if the animals exist in places which the scientists cannot reach, or if counting itself would in some way disturb or harm the animals. *TAG* teaches the student one technique that is used by the scientist to estimate the animal population in a designated area.

Most modern biology texts deal only briefly with a discussion of population problems. Generally, if population census is included at all, the presentation is brief and lacking in laboratory activities. The *TAG* unit presents the student with a detailed simulation of a real technique *(tagging and recovery)* used by scientists to estimate the size of a wildlife population.

It should also be clear that *TAG* offers the student a considerable time advantage. It is likely that an actual experiment which involves *tagging and recovery* of some species can be designed and run by the student; however, this sampling technique is characterized by the long time periods required for completing the sampling. If the student is attempting to learn good sampling techniques while the experiment is run, the completion time becomes unreasonably long. *TAG* offers the advantage of shortening this whole process.

III. DESCRIPTION OF THE *TAG* PROGRAM

The computer program in this unit asks the student to estimate the number of bass in a simulated farm pond using the technique of tagging and recovery. At the beginning of the problem, the computer asks the student to respond to the following questions:

```
HOW MANY TAGGED BASS DO YOU WANT FROM THE HATCHERY ?

HOW MANY DAYS AFTER RELEASE OF THE BASS FROM THE
CENTER OF THE POND DO YOU WANT TO SAMPLE ?

AT WHAT SITE DO YOU WANT TO SAMPLE FIRST
(REFER TO MAP IN STUDENT MANUAL FOR X AND Y COORDINATES.
ENTER AS X,Y) ?

HOW MANY FISH?
```

After these questions are answered, the computer prints the sample number (N), the number of tagged bass (M) and untagged bass (N-M) at the station (X,Y) for the day (T) requested.

The student may continue to get information for any day and station he wishes by responding to the questions:

```
ANOTHER SAMPLE ON DAY (T)  (1=YES, 0=NO)   ?

SITE COORDINATES  ?
HOW MANY FISH   ?
```

or

```
DO YOU WANT TO SAMPLE ON ANOTHER DAY (1=YES, 0=NO)   ?
WHAT DAY NO.  ?

AT WHAT SITE DO YOU WANT TO SAMPLE FIRST  ?
HOW MANY FISH   ?
```

When the student has stopped taking samples, the program prints out:

```
IF YOU HAVE SELECTED YOUR SAMPLES CAREFULLY
YOU SHOULD BE ABLE TO DETERMINE THE TOTAL
BASS POPULATION OF THE POND.

  Y O U CAN USE THE FORMULA:

  TOTAL POP.= (TOTAL TAGGED FISH IN POND) X (SAMPLE SIZE)
              -------------------------------------------
               (NUMBER OF TAGGED FISH RECOVERED AT SITE)


DO YOU WISH TO DO THE CALCULATIONS YOURSELF (1=YES, 0=NO)   ?
```

If the response is negative, the computer will ask the following question:

```
WHICH SAMPLE DO YOU WISH TO EVALUATE FIRST (SAMPLE NUMBER)   ?
```

The machine will then perform the calculations and print out the solution (rounded to the nearest whole integer) in the same format as used for the sampling formula. (See sample runs for examples.) The student may perform the calculations or have the machine do so for as many samples as he wishes.*

When the results for all samples have been calculated, the computer will instruct the student:

```
ENTER YOUR ESTIMATE OF THE UNTAGGED BASS POPULATION   ?
```

The word UNTAGGED is important. The student must subtract the number of tagged fish from the total population. Students should be encouraged to use the DATA SUMMARY SHEET to avoid confusion.

---

*If you want your students to do their own calculations and not have the option of using the computer, you can eliminate this option from the program. See Section IV, Part G, in the *RESOURCE MANUAL* for details.

If the student's estimate is within 10% of the correct answer, the program responds:

```
YOUR ESTIMATE IS GOOD.  CONGRATULATIONS.
```

If the sample is within 10% to 25%, the program prints:

```
YOUR ESTIMATE IS CLOSE, BUT NOT WITHIN 10% OF THE
ACTUAL POPULATION.
EXAMINE YOUR SAMPLING STRATEGY AND TRY AGAIN.
```

If the sample is not within 25% of the correct answer, it prints:

```
YOUR ESTIMATE WAS NOT WITHIN 25 PERCENT
OF THE ACTUAL POPULATION.
EXAMINE YOUR SAMPLING STRATEGY AND TRY AGAIN.
```

NOTE: Although *TAG* is easy to use, some confusion can result from the use of the formula required to estimate total population size. The formula gives an estimate for the total population in the pond at the time of sampling. This would also include the tagged fish as they are members of the same species. The formula also assumes that none of the tagged fish have died; this may not be true if long periods of time have elapsed since introduction of the fish.

IV. A SUCCESSFUL STRATEGY FOR *TAG*

A. Selection of Fish from the Hatchery

Since the student should be aware of the ecological advantages of tagging and recovery, he should use as few fish as possible. In general, 100 fish is more than enough to introduce into such a small pond. In reality, an ecologist would use many fewer fish.

Suggestion: Ask an interested student to continue study with *TAG* by checking the effects of using fewer fish. At what lower limit is reliability lost?

B. Selection of Days for Sampling

The fish are assumed to be introduced into the center of the pond at the beginning of Day 1. They diffuse outward toward the margins of the pond at a slow rate, determined by a diffusion constant (see Section IV in the *RESOURCE MANUAL*). The student should allow enough days for the introduced fish to randomly distribute themselves throughout the pond. If the student's samples indicate that the tagged fish are still not randomly distributed, encourage him to sample again on a later day. He can do this by responding to the following questions:

```
ANOTHER SAMPLE ON DAY (T) (1=YES,0=NO) ?  0

DO YOU WANT TO SAMPLE ON ANOTHER DAY (1=YES,0=NO) ?  1

WHAT DAY NO. ?
```

Sampling must not be delayed too long, however, or the tagged fish will begin to die (remember the offspring of the tagged fish will not carry tags). In general, about 30 days will be required if the student wants to obtain a good distribution, since diffusion starts rapidly but slows as time goes on. Since small errors are acceptable, however, samples may be taken at an earlier time.

C. Selection of Sampling Sites

The user is allowed to sample over the entire surface of the pond. To choose a site, a student should consult the map of the pond found in the *STUDENT MANUAL*. The X and Y coordinates of the chosen location should be determined and these numbers entered into the computer in the form of (value of X), (value of Y). For example, if the student wished to sample a location with the X coordinate of -35 and a Y coordinate of 10, the number would be entered into the computer as "-35,10".

Locations of sampling sites should be scattered over the entire surface of the pond, including areas near the border. Encourage your students to select at least 5 sampling sites in advance; this will speed their use of the teletype.

D. Calculation of the Untagged Bass Population

When the student has sampled 5 stations with fairly uniform recoveries, he can either perform the calculations or have the machine do them..

After all the samples have been calculated, the student should average those samples he feels to be representative of the pond as a whole. Since we assume that each fish is immediately returned to the pond after examination, it is possible that a sample might count the same fish several times; thus, the sample might not reflect the make-up of the entire population. In general, representative samples will show fairly good agreement for total population, if adequate time has been allowed for complete mixing of the tagged fish. The student determines the untagged population by subtracting the number of tagged fish from the average of the total population calculations (representative samples only).

NOTE: *TAG* assumes the untagged population remains constant at 424. This information is withheld, as it would not be available in a real-life situation.

V. SAMPLE RUNS OF *TAG*

RUN 1 -- POOR STUDENT STRATEGY

```
DO YOU REQUIRE INSTRUCTIONS (1=YES, 0=NO) ?1

    THE OBJECT IS TO DETERMINE THE NUMBER OF BASS
IN THE POND SHOWN IN YOUR LAB GUIDE. THE TECHNIQUE
CALLS ON YOU TO INTRODUCE TAGGED FISH INTO THE POND
AND, AT SOME LATER DATE, SAMPLE THE POND'S FISH
TO DETERMINE THE PERCENTAGE OF FISH THAT ARE TAGGED.
    YOU ARE ALLOWED ONLY 20 SAMPLES, SO CHOOSE CAREFULLY.
HOW MANY TAGGED BASS DO YOU WANT FROM THE HATCHERY ?80
HOW MANY DAYS, AFTER RELEASE OF THE BASS
FROM THE CENTER OF THE POND, DO YOU WANT TO SAMPLE ?10
AT WHAT SITE DO YOU WANT TO SAMPLE FIRST
(REFER TO MAP IN STUDENT MANUAL FOR X AND Y COORDINATES.
ENTER AS X,Y) ?0,0
HOW MANY FISH ?100
 SAMPLE:  1
STATION:  0 , 0     DAY:  10
 TAGGED:  26    UNTAGGED:  74

ANOTHER SAMPLE ON DAY  10  (1=YES, 0=NO) ?1

SITE COORDINATES ?35,-35
HOW MANY FISH ?100
 SAMPLE:  2
STATION:  35 ,-35     DAY:  10
 TAGGED:  19    UNTAGGED:  81
```

DAY 10 SAMPLES INDICATE THAT THE TAGGED FISH ARE STILL LARGELY CLUSTERED IN THE CENTER OF THE POND.

```
ANOTHER SAMPLE ON DAY  10 ?1

SITE COORDINATES ?-70,-5
HOW MANY FISH ?100
 SAMPLE:  3
STATION: -70 ,-5     DAY:  10
 TAGGED:  11    UNTAGGED:  89
```

```
ANOTHER SAMPLE ON DAY  10 ?1

SITE COORDINATES ?-40,12
HOW MANY FISH ?100
 SAMPLE:  4
STATION: -40 , 12      DAY:  10
 TAGGED:  20    UNTAGGED:  80


ANOTHER SAMPLE ON DAY  10 ?0

DO YOU WANT TO SAMPLE ON ANOTHER DAY (1=YES, 0=NO) ?1
WHAT DAY NUMBER ?20
```

THE STUDENT HAS ELECTED TO CONTINUE HIS SAMPLING ON DAY 20.

```
AT WHAT SITE DO YOU WANT TO SAMPLE FIRST ?0,0
HOW MANY FISH ?100
 SAMPLE:  5
STATION:  0 , 0      DAY:  20
 TAGGED:  16    UNTAGGED:  84

ANOTHER SAMPLE ON DAY  20 ?1

SITE COORDINATES ?35,-35
HOW MANY FISH ?100
 SAMPLE:  6
STATION:  35 ,-35      DAY:  20
 TAGGED:  11    UNTAGGED:  89
```

ON DAY 20, THE SAMPLING SITES NEAR THE CENTER OF THE POND (SUCH AS 0,0) INDICATE A HIGHER CONCENTRATION OF TAGGED FISH. THEREFORE, THE TAGGED FISH ARE STILL NOT RANDOMLY DISTRIBUTED.

```
ANOTHER SAMPLE ON DAY  20 ?1

SITE COORDINATES ?-70,5
HOW MANY FISH ?100
 SAMPLE:  7
STATION: -70 , 5      DAY:  20
 TAGGED:  13  UNTAGGED:  87
```

```
ANOTHER SAMPLE ON DAY  20 ?1

SITE COORDINATES ?-40,12
HOW MANY FISH ?100
 SAMPLE:  8
STATION: -40 , 12     DAY:  20
 TAGGED:  15    UNTAGGED:  85


ANOTHER SAMPLE ON DAY  20 ?0

DO YOU WANT TO SAMPLE ON ANOTHER DAY ?0
```

IN SPITE OF THE POOR DISTRIBUTION, THE STUDENT HAS STOPPED SAMPLING BY REPLYING TO THESE QUESTIONS WITH 0.

```
IF YOU HAVE SELECTED YOUR SAMPLES CAREFULLY
YOU SHOULD BE ABLE TO DETERMINE THE TOTAL
BASS POPULATION OF THE LAKE.

 YOU CAN USE THE FORMULA:
            (TOTAL TAGGED FISH IN POND) X (SAMPLE SIZE)
 TOTAL POP.= -----------------------------------------
              (NUMBER OF TAGGED FISH RECOVERED AT SITE)

DO YOU WISH TO DO THE CALCULATIONS YOURSELF(1=YES, 0=NO) ?0

WHICH SAMPLE DO YOU WISH TO EVALUATE FIRST (SAMPLE NUMBER) ?5

           80   X   100
          ---------------- =  500
                16


ANOTHER CALCULATION (1=YES,0=NO) ?1

(SAMPLE NUMBER) ?6

           80   X   100
          ---------------- =  727
                11
```

THE PROGRAM WILL CALCULATE THE TOTAL BASS POPULATION USING THE ABOVE FORMULA.

```
ANOTHER CALCULATION (1=YES,0=NO) ?1

 (SAMPLE NUMBER) ?7

          80    X    100
     ----------------- =  615
             13

ANOTHER CALCULATION (1=YES,0=NO) ?1

 (SAMPLE NUMBER) ?8

          80    X    100
     ----------------- =  533
             15

ANOTHER CALCULATION (1=YES,0=NO) ?0

ENTER YOUR ESTIMATE OF THE UNTAGGED BASS POPULATION ?514
```

THE STUDENT'S ESTIMATE IS AN AVERAGE OF THE TOTAL POPULATION FROM HIS DAY 20 SAMPLES MINUS THE NUMBER OF TAGGED FISH.

```
YOUR ESTIMATE IS CLOSE, BUT NOT WITHIN 10 PERCENT
OF THE ACTUAL POPULATION.
EXAMINE YOUR SAMPLING STATEGY AND TRY AGAIN.
```

RUN 2 -- IMPROVED STUDENT STRATEGY

```
DO YOU REQUIRE INSTRUCTIONS (1=YES, 0=NO) ?0


HOW MANY TAGGED BASS DO YOU WANT FROM THE HATCHERY ?100

HOW MANY DAYS, AFTER RELEASE OF THE BASS
FROM THE CENTER OF THE POND, DO YOU WANT TO SAMPLE ?40

AT WHAT SITE DO YOU WANT TO SAMPLE FIRST
(REFER TO MAP IN STUDENT MANUAL FOR X AND Y COORDINATES.
ENTER AS X,Y) ?0,0
HOW MANY FISH ?100
 SAMPLE:  1
STATION:  0 , 0      DAY:  40
 TAGGED:  19    UNTAGGED:  81
```

BY DAY 40 THE BASS HAVE HAD ADEQUATE TIME TO DISTRIBUTE THEMSELVES THROUGHOUT THE POPULATION.

```
ANOTHER SAMPLE ON DAY  40  (1=YES, 0=NO) ?1

SITE COORDINATES ?35,-35
HOW MANY FISH ?100
 SAMPLE:  2
STATION:  35 ,-35    DAY:  40
 TAGGED:  20    UNTAGGED:  80


ANOTHER SAMPLE ON DAY  40 ?1

SITE COORDINATES ?-70,-5
HOW MANY FISH ?100
 SAMPLE:  3
STATION: -70 ,-5      DAY:  40
 TAGGED:  17    UNTAGGED:  83


ANOTHER SAMPLE ON DAY  40 ?1

SITE COORDINATES ?-40,12
HOW MANY FISH ?100
 SAMPLE:  4
STATION: -40 , 12     DAY:  40
 TAGGED:  18    UNTAGGED:  82
```

NOTE THE FAIRLY UNIFORM SAMPLES FROM ALL AREAS OF THE POND.

```
ANOTHER SAMPLE ON DAY  40 ?1

SITE COORDINATES ?10,60
HOW MANY FISH ?100
 SAMPLE:  5
STATION:  10 , 60     DAY:  40
 TAGGED:  21    UNTAGGED:  79

ANOTHER SAMPLE ON DAY  40 ?0

DO YOU WANT TO SAMPLE ON ANOTHER DAY (1=YES, 0=NO) ?0

IF YOU HAVE SELECTED YOUR SAMPLES CAREFULLY
YOU SHOULD BE ABLE TO DETERMINE THE TOTAL
BASS POPULATION OF THE POND.

  YOU CAN USE THE FORMULA:
            (TOTAL TAGGED FISH IN POND) X (SAMPLE SIZE)
  TOTAL POP.= ------------------------------------------
              (NUMBER OF TAGGED FISH RECOVERED AT SITE)

DO YOU WISH TO DO THE CALCULATIONS YOURSELF(1=YES, 0=NO) ?0

WHICH SAMPLE DO YOU WISH TO EVALUATE FIRST (SAMPLE NUMBER) ?1

          100   X   100
        ---------------- =  526
              19


ANOTHER CALCULATION (1=YES,0=NO) ?1

 (SAMPLE NUMBER) ?2

          100   X   100
        ---------------- =  500
              20


ANOTHER CALCULATION (1=YES,0=NO) ?1

 (SAMPLE NUMBER) ?3

          100   X   100
        ---------------- =  588
              17
```

```
ANOTHER CALCULATION (1=YES,0=NO) ?1

 (SAMPLE NUMBER) ?4

          100    X   100
        ---------------- =  555
             18

ANOTHER CALCULATION (1=YES,0=NO) ?1

 (SAMPLE NUMBER) ?5

          100    X  100
        ---------------- =  476
             21



ANOTHER CALCULATION (1=YES,0=NO) ?0

ENTER YOUR ESTIMATE OF THE UNTAGGED BASS POPULATION ?429

YOUR ESTIMATE IS GOOD.  CONGRATULATIONS.
```

VI. PLAN FOR USING *TAG*

A. Preparation Activities. This unit might be introduced in the following manner:

1) Define what is meant by a wildlife population; that is, wildlife population is the total number of animals of a certain species in a given region.

2) Conduct a general discussion of the problem of determining the size of a wildlife population. Introduce the idea of direct counting versus sampling.

3) Have the students work the bean-seed exercise in the *STUDENT MANUAL*. A key to the exercise questions is given below. This exercise should act as an excellent introduction to sampling techniques.

4) After the bean-seed exercise is completed, conduct a discussion on the analogy between that exercise and the fish problem. Comments regarding this analogy are included in the key below. The students should now be in a good position to begin the program.

5) If students have an inadequate background in graphical skills, review technique for determining X and Y coordinates using the pond map from the *STUDENT MANUAL*.

B. Use of the Program

TAG is probably best suited to individual use or small group use (2 - 3 students); however, with careful preparation *TAG* can be used with groups of any size.

Students should be asked to give reasons for choosing certain sample sizes, recovery sites, and so forth; however, they may not have clear answers until they have used *TAG* to discover good tagging and sampling combinations.

C. Answer Key to Questions in the *STUDENT MANUAL* for the Bean-Seed Problem:

Fill a pint container approximately one-half full of bean seeds.

1) DEVISE AS MANY WAYS AS YOU CAN FOR ESTIMATING THE NUMBER OF BEAN SEEDS IN THE CONTAINER. FOR EACH METHOD THAT YOU DEVISE, COMPUTE AN ESTIMATE OF THE NUMBER OF BEAN SEEDS IN THE CONTAINER.

One method might be to calculate the volume of the container and the volume of one seed, then

$$\text{number of seeds} = \frac{\text{volume of container}}{\text{volume per seed}}$$

2) *DO YOU THINK THAT ANY OF THE METHODS WHICH YOU USED IN (1) COULD BE USED TO ESTIMATE THE FISH POPULATION IN A FARM POND WITHOUT ALTERING THE ECOLOGY OF THE POND? EXPLAIN.*

See the answer to (1). It might be possible to estimate the volume required by a single fish. Obviously, direct counting would alter the pond's ecology.

3) *COVER YOUR EYES AND DRAW OUT 20 BEAN SEEDS FROM THE CONTAINER. USE THE PROPORTIONS FORMULA $Q/P = M/N$ GIVEN ON PAGE 2 TO ESTIMATE THE TOTAL BEAN-SEED POPULATION IN THE CONTAINER. (BEFORE YOU CAN DO THIS, YOU WILL NEED TO DEFINE P, Q, N, AND M FOR THIS PROBLEM.)*

The proportions formula can be used after the student recognizes that

P = total number of bean seeds
Q = number of marked bean seeds
M = number of marked beans in sample
N = sample size

The analogy to the fish population problem is that the total number of fish (P) is analogous to the total number of bean seeds (P) and so forth.

4) *REPEAT THE PROCEDURE IN (3) THREE MORE TIMES; THEN FIND AN AVERAGE OF THE FOUR ESTIMATED VALUES FOR P.*

This is a straightforward exercise. Assume that 20 marked bean seeds are put into the container and 4 samples of 10 beans each are taken from the container. The following data might occur:

Sample (N = 10)	Total Number of Marked Beans (Q)	Marked Beans in Sample (M)	Population (P)
1	20	2	100
2	20	1	200
3	20	2	100
4	20	3	67

Average population estimate =

$$\frac{100 + 200 + 100 + 67}{4} = 116 \text{ bean seeds.}$$

5) *NOW REPEAT THE PROCEDURE DESCRIBED IN (3) WITH THE FOLLOWING CHANGE: AFTER THE FIRST BEAN SEED IS DRAWN FROM THE CONTAINER, RECORD WHETHER OR NOT IT IS MARKED, THEN RETURN IT TO THE CONTAINER AND SHAKE THE CONTAINER WELL. REPEAT THIS PROCESS UNTIL THE RESULTS OF 15 DRAWINGS HAVE BEEN RECORDED. NOW USE THE FORMULA TO DETERMINE THE BEAN-SEED POPULATION OF THE CONTAINER.*

6) *REPEAT THE PROCEDURE IN (5) THREE MORE TIMES: THEN FIND AN AVERAGE OF THE FOUR VALUES FOR P.*

This sampling procedure differs from (3) only in the returning of the bean seed to the total population after each drawing. This is an excellent sampling procedure. The fish sampling in *TAG* is done in this manner.

7) *NOW COUNT THE NUMBER OF BEANS IN THE CONTAINER. WHICH POPULATION ESTIMATE WAS THE MOST ACCURATE?*

Probably number (6) was the best. Numbers (3) and (5) are point estimates and it is very probable that they will be less accurate than the average estimates in (4) and in (6).

8) *IN VIEW OF YOUR ANSWERS TO (3), (4), (5), AND (6), DISCUSS EACH OF THE FOLLOWING QUESTIONS:*

a) *DO YOU THINK THE RESULTS WOULD HAVE BEEN DIFFERENT IF THE NUMBER OF MARKED BEANS HAD BEEN LARGER? SMALLER?*

The results would have been significantly different only if the number of marked beans put into the container were very small or very large compared to the number of unmarked beans.

b) *COMPARE YOUR RESULTS WITH THOSE OF ONE OF YOUR CLASSMATES WHO USED A CONTAINER WITH A DIFFERENT SHAPE. HOW DO YOU THINK THE SHAPE OF YOUR CONTAINER MIGHT HAVE AFFECTED YOUR RESULTS?*

Tagging and recovery calls for random sampling of the population after the diffusion process has resulted in the marked individuals (either beans or fish) being evenly distributed. Any container that either restricts mixing or that limits sampling to a very small part of the total population may adversely affect the student's results.

c) *SUPPOSE YOU HAD EMPTIED THE BEANS INTO A CONTAINER WITH A SURFACE AREA SUCH AS A PIE TIN. HOW WOULD YOU HAVE ALTERED YOUR TECHNIQUE FOR DRAWING OUT BEANS AND SHAKING THE CONTAINER? WHY? DO YOU THINK YOUR REASONING WILL APPLY TO THE FARM POND PROBLEM? DISCUSS.*

All the beans will be exposed for sampling. Since tagging and recovery requires a random sample, beans should be selected from all areas of the pie tin. The pond in *TAG* is similar to the pie tin in that both the pan and the pond are shallow and the population is spread thinly over the entire area.

d) IF YOU HAD DROPPED YOUR CONTAINER OF BEANS AND IN THE RECOVERY OF THEM MISSED A FEW, HOW GREAT AN EFFECT DO YOU THINK THIS WOULD HAVE ON YOUR RESULTS? CAN YOU SEE A POSSIBLE COMPARISON BETWEEN THIS SITUATION AND THE MORTALITY RATE FOR TAGGED FISH IN THE FARM POND? DISCUSS.

The loss of a few beans would cause little error; this corresponds to mortality among the bass. The program contains a mortality factor (C), but it has little effect during the usual sampling time.

e) A FACTOR WHICH DOES NOT ENTER INTO THE BEAN PROBLEM BUT WHICH IS BASIC TO THE FARM-POND PROBLEM IS THE FACTOR OF TIME. DISCUSS.

Time is an important factor because it takes time for the fish to mix -- about 15 days for total mixing to occur. After that, time is not a factor. The exception occurs for very long times, since then mortality has an important effect.